MITSUBISHI HEAVY INDUSTRIES AMERICA, INC.
AIRCRAFT PRODUCT SUPPORT DIVISION

MHIA18-013

May 31, 2018

Mr. Brian C. Rayner
Senior Air Safety Investigator
National Transportation Safety Board
[redacted]
Ashburn, VA 20147

Subject: MHIA Response to NTSB Email dated May 30, 2018

Dear Mr. Rayner,

Per your request, Mitsubishi Heavy Industries America, Inc. (MHIA) is submitting responses to your questions below:

Question #1:
Why was SFAR introduced to Mitsubishi MU-2B series aircraft?

Response #1:
Federal Aviation Administration (FAA) conducted an FAA Safety Evaluation Program after noticing rising accident rate for the Mitsubishi MU-2B series aircraft in early 2000's. As a result of Safety Evaluation, FAA determined that changes in training and operating requirements were needed. The Safety Evaluation produced a number of recommendations, including proposal of an SFAR. The FAA proposed that all ground and flight training conducted in the Mitsubishi MU-2B series aircraft be done using the standardized training program and a pilot checklist accepted by the FAA's Flight Standardization Board (FSB).

Question #2:
What steps should the MU-2 pilots take when encountering potential icing or actual icing conditions?

MHIA Response #2:
Mitsubishi Heavy Industries, Ltd. (MHI) issued Airplane Flight Manual (AFM), Pilots Operating Manual (POM), and Pilot Checklist (PCL) providing information on limitations in known-icing conditions and procedures in case of inadvertent icing encounter or severe icing encounter in flight. MHI made aircraft modifications available to MU-2 pilots to enhance the awareness of icing conditions. Added safety systems include Ice Detector System (STC SA00601WI), Automatic Autopilot Disconnect System (SA00489WI), Trim-In-Motion Alert System (SA00491WI), Pneumatic De-Ice Monitoring System (SA00482WI), and Auto-Ignition System (MHI SB 086/74-002). MHI also introduced an Icing Awareness Training Video to encourage MU-2 pilots to understand different kinds of icing and enhance awareness of icing conditions. Viewing this video is mandatory for all MU-2 pilots before flight into known or forecast icing conditions.

If you need any additional information, please feel free to contact Mr. Ralph Sorrells ([redacted] / [redacted]) or Mr. Yoshiaki Asako ([redacted] / [redacted]).

Sincerely,

[redacted]

Yoshiaki Asako
Director

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Attachments:
1. Airplane Flight Manual (Excerpt), MU-2B-40 Model, MR-0271-1, Rev. 14, dated August 24, 2016.
2. Pilot's Operating Manual (Excerpt), MU-2B-40 Model, MR-0335-1, Rev. 5, dated July 15, 2004.
3. Pilot Checklist (Excerpt), MU-2B-40 Model, YET 06256D, Rev. D, dated August 24, 2016.

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CABIN PRESSURIZATION SYSTEM

Maximum Differential Pressure ..... 6.10 PSI

AIRSPEED LIMITATIONS (KCAS) (M)

V_{MO} (Maximum operation limit) ..... 250 (Sea level to 21,300 feet pressure altitude)
M_{MO} (Maximum operating Mach number) ..... 0.57 (Above 21,300 feet pressure altitude)
V_A (Maneuvering) 182
V_{FO} (Flap operating)
Up to 5° 175
5° to 20° 155
20° to 40° 120
V_{FE} (Flap extended)
5° 175
20° , 40° 155
V_{LO} (Landing gear operating) 170
V_{LE} (Landing gear extended) 170
V_{LLO} (Landing Light operating) 175
V_{TIRE} ..... 139 (True speed on the ground)
V_{WW} (Windshield Wiper operating) 175
V_{MC} (Minimum control Flaps 5°) 100
(Flaps 20°) 93

MANEUVERING LOAD FACTORS

Maximum Positive : 3.28 (Flaps Up)
2.0 (Flaps Down)
Maximum Negative : -1.31 (Flaps Up)

MINIMUM CREW

1 (Pilot)

R For flight into known or forecasted icing conditions, the pilot-in-command must have satisfied the training requirements specified in FAA AD No. 2003-22-07 latest revision.

TYPES OF OPERATION / REQUIRED EQUIPMENT LIST

This is a normal category airplane approved for day/night, VFR/IFR and known icing conditions when properly equipped for the intended flight. The operator of the airplane is responsible for ensuring that the proper equipment is installed, approved and operational, for the intended flight, in order to comply with Federal Aviation Regulations (FAR) Part 91.

The following listed equipment is required to be installed, approved, properly maintained, and operable for the indicated type of flight. The listed equipment is not applicable for airplanes which are to be operated under FAR Part 135. Airplanes to be operated under Part 135 should refer to the Master Minimum Equipment List developed by the FAA Flight Operations Evaluation Board.

TYPES OF OPERATION / REQUIRED EQUIPMENT LIST (CONT)

FLIGHT ABOVE 25,000 FEET PRESSURE ALTITUDE

1. Supplemental Oxygen system
2. Oxygen mask available for each crew member and passenger with one crew mask plugged in and readily accessible

ICING CONDITIONS

1. Wing deicing
2. Propeller anti-icing
3. Engine air intake anti-icing
4. Oil cooler air intake anti-icing
5. Static and pitot anti-icing
6. Stall warning anti-icing
7. Heated windshield anti-icing
8. AOA probe (if installed) anti-icing

R **PNEUMATIC DEICING BOOTS OPERATIONS**

R Wing and Tail Leading Edge Pneumatic Deicing Boots System must be activated:

R - At the first sign of ice formation anywhere on the aircraft, or upon annunciation from an ice detector system, whichever occurs first; and
R - The system must either be continued to be operated in the automatic cycling mode, or the system must be manually cycled as needed to minimize the ice accretions on the airframe.

R The wing and tail leading edge pneumatic deicing boots system may be deactivated only after leaving icing conditions and after the airplane is determined to be clear of ice.

ICING LIMITATIONS

Minimum airspeed for sustained level flight in icing conditions ..... 180 KIAS

Sustained flight in icing conditions with flaps extended is prohibited except for approach and landing.

ICING LIMITATIONS (CONT)

WARNING

SEVERE ICING MAY RESULT FROM ENVIRONMENTAL CONDITIONS OUTSIDE OF THOSE FOR WHICH THE AIRPLANE IS CERTIFICATED. FLIGHT IN FREEZING RAIN, FREEZING DRIZZLE, OR MIXED ICING CONDITIONS (SUPERCOOLED LIQUID WATER AND ICE CRYSTALS) MAY RESULT IN ICE BUILD-UP ON PROTECTED SURFACES EXCEEDING THE CAPABILITY OF THE ICE PROTECTION SYSTEM, OR MAY RESULT IN ICE FORMING AFT OF THE PROTECTED SURFACES. THIS ICE MAY NOT BE SHED USING THE ICE PROTECTION SYSTEMS, AND MAY SERIOUSLY DEGRADE THE PERFORMANCE AND CONTROLLABILITY OF THE AIRPLANE. IN SOME CASES THE ICE MAY APPEAR TO BE OF RELATIVELY SMALL PROPORTIONS. OFTEN THE APPEARANCE OF THE ICE CAUSING THE MOST SEVERE CONSEQUENCES IS GLAZE ICE OR A COMBINATION OF GLAZE ICE AND RIME ICE.

DURING FLIGHT, SEVERE ICING CONDITIONS THAT EXCEED THOSE FOR WHICH THE AIRPLANE IS CERTIFICATED SHALL BE DETERMINED BY THE FOLLOWING VISUAL CUES. IF ONE OR MORE OF THESE VISUAL CUES EXIST, IMMEDIATELY REQUEST PRIORITY HANDLING FROM AIR TRAFFIC CONTROL TO FACILITATE A ROUTE OR AN ALTITUDE CHANGE TO EXIT THE ICING CONDITIONS.

1. AIRSPEED LOSSES GREATER THAN 20 KIAS THAT ARE NOT REGAINED AFTER A BOOT DEICE CYCLE.
2. DECREASE IN RATE OF CLIMB DURING A CONSTANT AIRSPEED CLIMB TO 300FT/MIN.
3. UNUSUALLY EXTENSIVE ICE ACCRETED ON THE AIRFRAME IN AREAS NOT NORMALLY OBSERVED TO COLLECT ICE. (E.G., LARGE GRANULAR ICE BUILD-UP ON THE WINDSHIELD AND ICE ACCUMULATING AROUND THE WELD LINE ON THE TIP TANKS.)
4. ACCUMULATION OF ICE ON THE LOWER SURFACE OF THE WING AFT OF THE PROTECTED AREA.
5. ACCUMULATION OF ICE ON THE PROPELLER SPINNER FARTHER AFT THAN NORMALLY OBSERVED.
6. ACCUMULATION OF ICE ON THE UPPER SURFACE OF THE WING AFT OF THE DEICING BOOTS VISIBLE FROM THE PILOT'S POSITION THAT IS NOT REMOVED BY DEICE BOOT OPERATION.

NOTE

Ice accretion beyond the limit of the boots on the upper surface may be visible from the pilot's position as a solid or partial ridge of ice.

ICING LIMITATIONS (CONT)

> SINCE THE AUTOPILOT MAY MASK TACTILE CUES THAT INDICATE ADVERSE CHANGES IN HANDLING CHARACTERISTICS, USE OF THE AUTOPILOT IS PROHIBITED WHEN ANY OF THE VISUAL CUES SPECIFIED ABOVE EXIST, OR WHEN UNUSUAL LATERAL OR LATERAL/YAW TRIM REQUIREMENTS ARE ENCOUNTERED WHILE THE AIRPLANE IS IN ICING CONDITIONS.

All icing detection lights (tip tank taxi lights, if installed, and wing ice detection light) must be operable prior to flight into known or forecast icing conditions at night.

TAKEOFF AND LANDING OPERATIONS

Ambient Temperatures ..... Maximum ISA +30°C
Minimum -54°C

Airport elevation ..... 8,000 feet pressure altitude maximum

Windshield HI HEAT operation prohibited during takeoff or landing

ENGINE SYNCHROPHASER - OFF for Takeoff, Approach, Landing, and Single Engine Operation

PROPELLER FEATHER VALVE AND NTS SYSTEM

R Prior to the first flight of the day and before every flight during which an intentional engine shutdown is planned, the feather valve check (detailed in Section 5, Normal Procedures) must be performed. This check must also be performed before the first flight after the feathering linkage is adjusted and/or after any maintenance of the feathering system is performed. Negative torque sensor (NTS) check must be performed before every flight. The NTS check is accomplished when "starting engines" and "after starting engines" (in Section 5, Normal Procedures) are completed.

TAKEOFF

Demonstrated Crosswind Takeoff ..... 22 KTS

All Anti-Ice Systems must be ON prior to takeoff in visible moisture if OAT is +10°C or colder.

Air Conditioning and Pressurization ..... OFF (Performance Section 6 is predicated on no bleed air losses)

SRL System must be operative.

R With the **Battery Temp 120°** annunciator
R illuminated ..... Takeoff Prohibited

LANDING

Demonstrated Crosswind Landing ..... 18 KTS

Maximum Tip Tank fuel quantity each tank ..... 400 pounds

Maximum Demonstrated Fuel Unbalance ..... 150 pounds
(Tip Tank and Outer Tank combined)

NO FLAP APPROACH AND LANDING

ON DOWNWIND LEG

1. Before Landing Checklist ..... COMPLETE
2. Airspeed ..... 150 KCAS MINIMUM
3. Landing Gear ..... DOWN - OPPOSITE OF LANDING POINT

ON BASE LEG

4. Airspeed ..... 140 KCAS MINIMUM
5. Landing Gear ..... CHECK DOWN

ON FINAL APPROACH

6. Airspeed ..... 1.25 V_{S_1} BUT NOT BELOW 115 KCAS

NOTE

Landing distance will increase approximately 30%.

EMERGENCY EXIT DOOR OPERATION

1. Manual Pressure Control Valve .... FULL DECREASE

When cabin is depressurized:

2. Handle Access Cover ..... PUSH IN
3. Emergency Exit Door Handle ..... PULL, THEN LIFT DOOR UP AND INWARD

R ## INADVERTENT ICING ENCOUNTER

NOTE

Conditions exist for icing when the outside air temperature (OAT) on the ground is +10°C or below or the indicated OAT (RAT) in flight is +10°C or below and visible moisture in any form is present.

WARNING

IN THE EVENT OF AN INADVERTENT ICING ENCOUNTER, IMMEDIATE ACTION MUST BE TAKEN BY THE PILOT WHEN THE SITUATION IS DISCOVERED:

1. **MAINTAIN AIRPLANE CONTROL.**
2. **CHECK ENGINE INLETS AND WING LEADING EDGES AND TAKE APPROPRIATE ACTION AS DESCRIBED IN THE FOLLOWING PROCEDURE. (PG 4-7)**
3. **EXIT ICING CONDITIONS, IF REQUIRED.**

INADVERTENT ICING ENCOUNTER (CONT)

IN ORDER TO MINIMIZE ICE ACCUMULATIONS ON UNPROTECTED LOWER SURFACES, MAINTAIN A MINIMUM SPEED OF 180 KIAS DURING OPERATIONS IN SUSTAINED CRUISE IN ICING CONDITIONS. THIS WILL PROVIDE AN ANGLE OF ATTACK THAT REDUCES EXPOSURE (FRONTAL AREA) OF THE LOWER SURFACES TO ICE ACCUMULATION. IF UNABLE TO MAINTAIN 180 KIAS AT MAXIMUM CONTINUOUS POWER, A CHANGE IN ALTITUDE AND/OR COURSE MAY BE NECESSARY TO MAINTAIN MINIMUM AIRSPEED AND/OR EXIT THE ICING CONDITIONS.

IF ICE HAS BEEN ALLOWED TO BUILD UP ON THE ENGINE AIR INLET, IT MUST BE REMOVED AS SOON AS POSSIBLE. HOWEVER, BEFORE ACTIVATING THE ENGINE AIR INTAKE ANTI-ICE, THE PILOT SHOULD BE AWARE THAT AS THE ICE IS REMOVED, IT COULD DISRUPT THE AIRFLOW TO THE ENGINE AND RESULT IN FLAMEOUT OF THAT ENGINE. THE PILOT SHOULD BE PREPARED FOR THE POSSIBILITY OF SINGLE ENGINE OPERATION.

1. Anti-Ice Systems ..... ON, (Except engine air intake anti-ice)
2. De-Ice ..... ON
3. Ignition Switches ..... CONT (If Auto-Ignition installed)
   ON (If Continuous Ignition installed)
4. LH Engine Air Intake Anti-Ice ..... ON

When proper operation of the LH engine is assured

5. RH Engine Air Intake Anti-Ice ..... ON

When proper operation of both engines is assured

6. Ignition Switches ..... CONT (If Auto-Ignition installed)
   ON (If Continuous Ignition installed),
   OBSERVE LIMITS

SEVERE ICING ENCOUNTER

THE FOLLOWING DESCRIBES SOME OF THE WEATHER CONDITIONS THAT MAY BE CONDUCIVE TO SEVERE IN-FLIGHT ICING:

1. Visible rain at temperatures below 0 degrees Celsius ambient air temperature.
2. Droplets that splash or splatter on impact at temperatures below 0 degrees Celsius ambient air temperature.

PROCEDURES FOR EXITING SEVERE ICING ENVIRONMENT:

Procedures for exiting severe icing environment are applicable to all flight phases from takeoff to landing. Monitor the ambient air temperature. While severe icing may form at temperatures as cold as -18 degrees Celsius, increased vigilance is warranted at temperatures around freezing with visible moisture present. If the visual cues specified in the Operating Limitations Section of the AFM for identifying severe icing conditions are observed, accomplish the following:

R SEVERE ICING ENCOUNTER (CONT)

R PROCEDURES FOR EXITING SEVERE ICING ENVIRONMENT: (CONT)

1. Immediately request priority handling from Air Traffic Control to facilitate a route or an altitude change to exit the severe icing conditions to avoid extended exposure to flight conditions more severe than those for which the airplane has been certificated.
2. Avoid abrupt and excessive maneuvering that may contribute to control difficulties.
3. Do not engage the autopilot.
4. If the autopilot is engaged, hold the control wheel firmly and disengage the autopilot.
5. If an unusual roll response, an uncommanded roll, or an unusual trim is observed, lower the nose (reduce the angle of attack) and allow the airspeed to increase before any reduction in engine power.
6. Do not extend flaps during extended operation in icing conditions. Operation with flaps extended can result in a reduced wing angle-of-attack, with the possibility of ice forming on the upper surface further aft on the wing than normal, possibly aft of the protected area.
7. If the flaps are extended, do not retract them until the airframe is clear of ice.
8. Report these weather conditions to Air Traffic Control.

VISIBLE MOISTURE ENCOUNTERS (CONT)

CAUTION

DURING ALL OPERATIONS IN VISIBLE MOISTURE, CAREFULLY MONITOR EGT. DO NOT ALLOW EGT TO EXCEED 650°C.

R INADVERTENT ICING ENCOUNTER

R 1. Ignition Switches ..... BOTH CONT (If Auto-Ignition installed)
R or ..... BOTH ON (If Auto-Ignition not installed)
R 2. LH Engine Intake Anti-Ice ..... ON

R **WARNING**

R **WHEN ICING CONDITIONS ARE ENCOUNTERED DO NOT DELAY OPERATION OF THE ENGINE INLET ANTI-ICE SYSTEMS.**

R 3. Remaining Anti-Ice/Deice Systems ..... ON (AS REQUIRED)

R When Proper Operation of the LH Engine is Assured:
R 4. RH Engine Intake Anti-Ice ..... ON

R When Proper Operation of Both Engines is Assured:
R 5. Ignition Switches ..... BOTH AUTO (If Auto-Ignition installed)

FLIGHT IN ICING CONDITIONS

NOTE

Conditions for icing exist when the outside air temperature (OAT) on the ground is +10°C or below or the indicated OAT (RAT) in flight is +10°C or below and visible moisture in any form is present.

Icing conditions also exist when the OAT on the ground is +10°C or below and where surface snow, slush, ice or standing water may be ingested by the engines or freeze on engine inlets or engine sensor probes.

WARNING

DUE TO DISTORTION OF AIRFOILS, STALLING SPEEDS SHOULD BE EXPECTED TO INCREASE AS ICE ACCUMULATES ON THE AIRPLANE. STALL WARNING DEVICES MAY NOT BE ACCURATE AND SHOULD NOT BE RELIED UPON.

FLIGHT IN ICING CONDITIONS (CONT)

IN ORDER TO MINIMIZE ICE ACCUMULATIONS ON UNPROTECTED LOWER SURFACES, MAINTAIN A MINIMUM SPEED OF 180 KIAS DURING OPERATIONS IN SUSTAINED CRUISE IN ICING CONDITIONS. THIS WILL PROVIDE AN ANGLE OF ATTACK THAT REDUCES EXPOSURE (FRONTAL AREA) OF THE LOWER SURFACES TO ICE ACCUMULATION. IF UNABLE TO MAINTAIN 180 KIAS AT MAXIMUM CONTINUOUS POWER, A CHANGE OF ALTITUDE AND/OR COURSE MAY BE NECESSARY TO MAINTAIN MINIMUM AIRSPEED AND/OR EXIT THE ICING CONDITIONS.

FOR OPERATION IN ICING CONDITIONS IN OTHER THAN SUSTAINED CRUISE, INCREASE NORMAL SPEEDS BY AT LEAST 10% WITHIN OPERATIONAL AIRCRAFT LIMITS.

DURING LANDING, DO NOT SELECT 40° FLAPS WHEN OPERATING IN ICING CONDITIONS. THE FAA HAS DETERMINED THAT ICE ACCUMULATIONS ON THE TAIL PLANE OF MANY AIRCRAFT MAY RESULT IN A REDUCED DOWN FORCE ON THE HORIZONTAL STABILIZER WHEN FULL FLAPS ARE USED. THIS REDUCED DOWN FORCE MAY RESULT IN THE AIRCRAFT PITCHING NOSE DOWN.

CLIMB CHECK

1. Altimeters ..... SET 29.92 INCHES HG. (AS REQUIRED)
2. Cabin Pressurization ..... CHECK
3. Oxygen/Crew Mask ..... CHECK (AS REQUIRED)
4. Fuel Balance and Transfer ..... CHECK
5. Windshield Heat ..... LOW
6. Pitot Heat ..... ON
7. Generator Load ..... CHECK

R R R 8. Ignition Switches ..... AUTO (If Auto-Ignition installed)
(Ignition Annunciator Lights extinguished)
or ..... AS REQUIRED (If Auto-Ignition not installed)

9. Anti-Ice/Deice Systems ..... AS REQUIRED

CRUISE

1. Power ..... SET AS REQUIRED (96% RPM to 98% RPM)

CAUTION

DO NOT MOVE CONDITION LEVER BELOW MIN CRUISE DURING FLIGHT EXCEPT TO FEATHER A FAILED ENGINE.

2. Engine Instruments ..... MONITOR
3. Generator Load ..... CHECK - OBSERVE PLACARD LIMITATIONS
4. Fuel Transfer Control Switches ..... OFF - AFTER TIP TANKS AND OUTER WING TANKS ARE EMPTY

R R R 5. Ignition Switches ..... AUTO (If Auto-Ignition installed)
(Ignition Annunciator Lights extinguished)
or ..... AS REQUIRED (If Auto-Ignition not installed)

6. Anti-Ice/Deice Systems ..... AS REQUIRED

OPERATING DETAILS (CONT)

COLD WEATHER OPERATION (CONT)

NOTE

It is recommended to utilize external power source, be cause of higher cranking power required, when starting engines at lower ambient temperatures.

When landing on a slush or ice covered runway, retract the flaps immediately after positive touchdown in order to prevent flap damage resulting from particles thrown against them by the wheels or prop wash. Also utilize continuous ignition within the limits of the duty cycle.

During landing roll, use the brakes sparingly and apply them cautiously to avoid skidding, while utilizing the reverse pitch effect of the propellers. Apply only enough brake pressure to slow the wheels. Do not lock them. When you have slowed the airplane and are ready to turn off the active runway, use rudder and nose wheel steering and, if necessary, differential power of engines for directional control. When parking the airplane, place chocks under all wheels and DO NOT set the parking brake.

FLIGHT IN ICING CONDITIONS

Operation in icing conditions has several effects on all airplanes. Ice accumulation on an airplane increases buffet/stalling speeds and airframe drag. Ice on propellers reduces thrust at the same indicated torque. These effects, in turn, result in reduced climb capability, reduced airspeed capability, increased power setting requirements, and increased fuel consumption. In accordance with MU-2B Airplane Flight Manual procedures, a minimum airspeed of 180 KIAS must be maintained in sustained cruise and additional speed should be carried on landing approach whenever any residual ice is on the airframe. Procedural changes are also presented in the Airplane Flight Manual for operation in icing. Due to these effects it is recommended the pilot avoid icing conditions whenever possible. This includes ground icing conditions where it is the pilot's responsibility to assure that the airframe, engines and propellers are free of snow and ice prior to engine start and prior to take off.

The MU-2B is equipped with several systems designed to protect the airplane from hazards that may be encountered in icing conditions as defined in the Federal Aviation Regulations (FAR Part 25 Appendix C). Design and analysis of these systems, as well as flight experience, led to FAA approval for flight into known icing conditions. It is understood, however, that severe icing conditions exist that are beyond the FAA requirements and capability of any ice protection system. Recent data on Supercooled Large Droplets (SLD) as well as freezing rain and drizzle have shown that these conditions can overcome any ice protection system. As demonstrated in the MHI icing awareness training video, pilots must take immediate action to exit these conditions when encountered. Visual cues to the pilot are presented in the Airplane Flight Manual to aid in identifying these conditions. Flight tests of the MU-2B have shown that the certified ice protection systems provide a sufficient level of protection for the pilot to recognize and exit severe conditions. It is the pilot's responsibility to recognize and immediately act to exit severe icing conditions. It is recommended that pilots never plan a mission into icing conditions that are forecast or reported to be worse than 'light to moderate'.

OPERATING DETAILS (CONT)

FLIGHT IN ICING CONDITIONS (CONT)

Flight into known icing conditions must be conducted with care and requires the pilot to verify all required equipment identified in the Limitations section of the Airplane Flight Manual are installed and functional. When flight into icing conditions is not avoidable, all anti-icing and deicing equipment must be properly utilized. Procedures for preflight checking and operation of these systems are detailed in the Airplane Flight Manual. Preflight planning should include selecting a suitable cruise altitude that will allow diversion into warmer air and out of icing conditions should they become severe. In addition, the pilot must have sufficient fuel reserves to deal with increased fuel burn associated with potential ice accumulation on the airframe, flight path deviations around weather, altitude changes, and a suitable alternate destination. A thorough preflight briefing of reported and forecast weather, pilot reports, and ATC observations will aid in the cruise altitude selection, alternate plans and eventual 'go/no-go' decision. If there is any doubt about the severity of icing conditions, the flight should be delayed or cancelled.

When approaching areas of icing, turn on all anti-icing and continuous ignition systems before entering these conditions. In accordance with flight manual procedures, activate the wing de-ice system at the first sign of ice accumulation on the airframe, or annunciation of the ice detector, whichever occurs first. Frequently monitor airspeed and ice accumulation being alert for speed deterioration and/or signs of SLD. Pilot cues for SLD conditions are detailed in the Airplane Flight Manual.

WARNING

IF THE INDICATED AIRSPEED DETERIORATES BY 10% OF NORMAL SUSTAINED CRUISE SPEED, OR A MINIMUM OF 180 KIAS CANNOT BE MAINTAINED, THE PILOT SHOULD TAKE IMMEDIATE PRECAUTIONARY ACTION TO FLY TO WARMER AIR AND OUT OF THE ICING CONDITIONS.

No Manufacturer's Pilot Manual is intended to teach pilots how to fly. It is assumed that pilots meet the standards of regulatory agencies, such as the FAA in the United States, to be licensed to fly multi-engined aircraft in instrument meteorological conditions. In addition, MHI strongly encourages all pilots of MU-2B airplanes to attend initial and recurrent training specific to this model. Likewise the FAA has issued an AD requiring all pilots to view the MHI icing awareness training video once every two years prior to acting as pilot-in-command of a flight into known icing conditions. This requirement is meant to be an aid to the pilot in recognizing the cues of ice buildup on the aircraft that, if not attended to, could result in loss of performance and, in extreme cases, loss of control.

Pilots, as part of basic training, should know that flight in icing conditions is one of the most critical phases of flight that can be encountered. They should also know that they have a number of available systems that directly and indirectly tell them that ice is accumulating on the aircraft and/or that icing can be expected to be encountered. Some of the systems that must be frequently monitored are:

OPERATING DETAILS (CONT)

FLIGHT IN ICING CONDITIONS (CONT)

1. The airspeed indicator, which will show a decrease as ice accumulates.
2. The OAT, which will give total air temperature. Whenever this is 10 degrees C or below and there is visible moisture, you should expect icing.
3. The radar will show areas of precipitation ahead.
4. The engine instruments may show a reduction in EGT when flying in moisture or icing conditions.
5. The DME may show a reduced ground speed.
6. The Rosemount Ice detector will announce icing with approximately 0.020 inches of ice accumulation.
7. Ice can be observed on the edges of the windshield, windshield wipers, tip tank leading edge, wing tie-down ring, wing leading edges and propeller spinner.
8. At night, ice can be observed by turning on the wing ice light, the tip tank taxi light (if installed), the windshield and looking at protuberances with a flashlight; and,
9. The autopilot trim may begin to trim frequently in the airplane nose-up direction if the autopilot is engaged and an altitude hold or rate hold mode is selected.

Prudent pilots take precautions when operating in icing conditions and monitor all systems to assure safety of operation and well being for the passengers.

The prudent pilot must remain alert to the possibility that icing conditions may exceed the capabilities of their equipment. At the first indication that such conditions may be ahead or may have been encountered, the pilot must select the most expeditious and safe course of action. The decision should be based on weather briefing, recent pilot reports and ATC observations, and basic weather flight training.

We recommend the book WEATHER FLYING by Robert N. Buck as an excellent source for the information and knowledge essential for safe all weather flight. This book includes valuable information for identifying the most favorable altitudes for flight in known icing conditions. Before getting into ice - when icing conditions are possible - an aware pilot knows what the IAS is and the right power settings, piston or jet. Then, once in ice, these settings are observed carefully for any changes. Change in IAS is a sure way to know the ice is affecting the aircraft, and power changes say heat had better be applied quickly. The early stage is the time to do something about getting out of the ice. It is folly to plug along without flexibility of thought, and willingness to realize that one may have to fly differently, change route, go IFR, divert, or even turn back. (Pp, 61, 228) It is the inexperienced or uneducated pilot who presses on "regardless", hoping that steadily worsening conditions will improve, only to find himself flying an airplane which has become so loaded with ice that he can no longer maintain altitude. At this point he has lost most if not all of his safety options, including perhaps, a 180 degree turn to retreat along the course already traveled. The responsible and well informed pilot recognizes the limitations of his airplane and its systems and reacts accordingly.

OPERATING DETAILS (CONT)

FLIGHT IN ICING CONDITIONS (CONT)

When flight in icing conditions is unavoidable, all anti-icing and deicing equipment should be properly utilized. The pilot should select the optimum altitude to meet the specific icing circumstances with the objective to fly to warmer air and out of the icing conditions as soon as possible. Remember that a sure way to gain the attention and assistance of Air Traffic Controllers is to report icing conditions. They can be of value to you in finding more favorable flight conditions.

The pilot should incorporate these important elements into the plan for flight into icing conditions:

1. All anti-icing and de-icing systems for power plant, propeller, stall warning, and pitot-static heat systems must be turned ON before entering an icing area. In addition, engine ignition should be selected ON or CONT in accordance with flight manual procedures. Auto-ignition, if installed, should be verified in the AUTO position for aircraft not equipped with the 'continuous duty cycle' ignition boxes per SB 086/74-002.
2. WINDSHIELD HI HEAT switch shall be turned ON for ice removal only. The windshield wiper may be used at the same time to remove melted ice.

NOTE

Do not operate wiper on a dry windshield or above 175 KIAS.

3. Select WING DE-ICE switch ON at the first sign of ice accumulation on the airframe, or annunciation of the ice detector (SB 80/30-003), in accordance with FAA AD 2000-09-15 (see the Limitations section of the Airplane Flight Manual). System shall remain in the automatic mode until the airplane has exited that icing condition and the airframe is clear of ice. During icing conditions, monitor ice accumulation/shedding on the wings. If deicing effect in the automatic mode is not satisfactory due to extreme icing conditions, repetition of intermittent manual operation may be required. However, very rapid manual cycling of the wing and tail deice boots (less than 16 seconds) reduces deicing efficiency.
4. Minimum sustained cruise speed in icing conditions is 180 KIAS. Use engine power as required to maintain normal cruise airspeeds. If unable to maintain 180 KIAS, sacrifice altitude to maintain airspeed. Change altitude and/or course as required to exit icing conditions. The pilot must monitor airspeed closely when using the autopilot in any of the hold modes to assure the airspeed does not slow below 180 KIAS during cruise flight. Autopilot use in some icing conditions is prohibited by the AFM.
5. Holding in icing conditions should be avoided. If assigned to hold in moderate or severe icing conditions the pilot should advise ATC and request an altitude and/or course change. If icing is unavoidable, hold with flaps and gear UP. Do not allow the airspeed to slow below 180 KIAS and expect increased engine power requirements. Ice may collect behind the leading edge boots on the lower surface of the wing. This increases the power requirement and should be closely monitored. The pilot should disconnect the autopilot occasionally to verify flight characteristics with any residual ice accumulation. Hold control wheel firmly prior to disconnecting the autopilot to assure no unusual characteristics.

OPERATING DETAILS (CONT)

FLIGHT IN ICING CONDITIONS (CONT)

6. Flap and gear extension should be performed as late as practical when in icing conditions to minimize ice formation. On approach, cycle the wing deice boots to clear the accumulated ice then select the system OFF to preclude boot inflation on landing. If there is any residual ice on the wings, increase landing approach speed by at least 15 kts.
7. Monitor wing leading edges, windshield, engine air inlet, wing tip tank leading edge, and propeller spinner for icing buildup inflight. If any of the indications of SLD identified in the Airplane Flight Manual are noted, immediate action must be taken to exit the conditions. Likewise, if the pilot sees any indication that the ice protection systems are not able to cope with the icing conditions, or an uncommanded speed decrease, immediate action must be taken to exit the icing conditions.

If icing conditions are inadvertently encountered (for example high altitude flight in the summer), or if ice has been permitted to collect on the engine air intake, activate Continuous Ignition switches immediately. Then turn one Engine Intake Anti-Ice switch ON. Assure proper operation of that engine prior to selecting the Engine Intake Anti-ice switch ON for the other engine. When proper operation of both engines is assured, and all of the ice is removed from the inlet and propeller spinner, the ignition switches can be returned to 'AUTO' (SB 86/74-002).

If ice has been permitted to build on the engine air intake do not activate even one engine air intake anti-ice system unless you are certain that control can be maintained on one engine. Assure that continuous ignition is ON or CONT and change flight condition to assure control can be maintained in event of one engine failure. Refer to Abnormal Procedures, "Inadvertent Icing Encounter" in the Airplane Flight Manual for the complete procedure.

If ice accumulates in the engine air intake(s), engine flameout may occur when the airplane flies from colder temperatures to warmer temperatures, such as in a descent. Ignitions should be ON or CONT(aircraft with continuous duty ignition boxes) or AUTO(aircraft without continuous duty boxes) to initiate a relight.

In unusually severe icing conditions, propeller icing can be a problem that is only indicated by a rapid speed decrease (.2 to .5 kts per sec.). This speed change has been observed with relatively benign appearing ice accumulations on the airframe but video coverage of the propeller showed ice accumulation on the leading edge of each propeller blade. Ice on the propeller reduces propeller efficiency and has the same effect as a significant drag increase on the airframe. Therefore, the pilot must have constant 'airspeed awareness' when in heavy icing conditions and have a plan to exit these conditions if encountered.

The Airplane Flight Manual presents expanded Limitations and Procedures for operation in icing. Any pilot planning a flight into known or forecast icing must be familiar with this information. In addition, in accordance with an FAA AD any pilot-in-command of an MU-2B planning a flight into known or forecast icing conditions must have viewed the current version of MHI icing awareness training videos and have a logbook signoff. This is for your own protection as well as your passengers well being.

OPERATING DETAILS (CONT)

FLIGHT IN ICING CONDITIONS (CONT)

MHI has provided ice protection systems for your MU-2B to minimize the risks associated with flight in icing conditions. For your own protection, these systems must be in good working order and functionally checked in the preflight. Complete flight planning for these conditions include checking for alternate altitudes, routes, alternate airports and additional fuel requirements. The most effective ice protection system is a pilot who respects the weather conditions and is prepared to take decisive action in event the weather conditions are more severe than anticipated.

GROUND HANDLING

Ground handling consists of mooring, towing and parking. When handling the airplane on the ground, observe the following:

1. If necessary, remove control surface locks during towing and taxiing.

2. Before starting engine:

   a. Remove all towing equipment.
   b. Remove control surface locks.
   c. Remove engine intake and tail pipe covers.
   d. Connect nose gear torque arm.
   e. Head the airplane into the wind and chock wheels.
   f. Keep all personnel, workstands and equipment out of the dangerous area.
   g. Set the parking brake.

MOORING AND TIE DOWN

When mooring the airplane in the open, head the airplane into the wind and proceed as follows:

1. Retract the flaps.

2. Set trim tabs in neutral position.

3. Install the external control surface locks.

4. Set the parking brake, if low ambient or freezing temperatures are not expected.

EMERGENCY EXIT DOOR OPERATION

1 Manual Pressure Control Valve ..... FULL DECREASE

When cabin depressurized:

2 Handle Access Cover ..... PUSH IN

3 Emergency Exit Door Handle..... PULL, THEN LIFT DOOR UP AND INWARD

INADVERTENT ICING ENCOUNTER

1 Anti-ice (except engine) ..... ON

2 Wing De-ice ..... ON

3 Ignition Switches.....CONT OR ON

4 LH Engine Intake Anti-ice..... ON

When proper operation of the LH engine is assured:

5 RH Engine Intake Anti-ice ..... ON

When proper operation of both engines is assured:

6 Ignition Switches.....CONT OR ON, OBSERVE LIMITS

SEVERE ICING ENCOUNTER

1 Priority Handling ..... REQUEST

2 Abrupt Maneuvering ..... AVOID

3 Control Wheel ..... HOLD

4 Autopilot..... DISENGAGE

5 Airspeed ..... INCREASE (180 KIAS MINIMUM IN CRUISE)

6 Power ..... MAINTAIN OR INCREASE

7 Flaps.....MAINTAIN

8 Report conditions to Air Traffic Control

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CONT or ON if runway is contaminated, raining, or in icing conditions. Also, CONT or ON shortly following exit from icing conditions whenever ice remains forward of the engine nacelle. (Observe ignition duty cycle limits). Otherwise, for aircraft with auto ignition installed, AUTO.

22 Wing De-ice ..... OFF 5-19

NOTE

If the wing deice system is in auto during the approach, cycle the wing deice off and on to allow one additional cycle, then select the system off prior to landing. 5-19

23 Autopilot/Yaw Damper ..... OFF

Final approach (landing assured):

24 Airspeed ..... $1.25V_S$ (115 KCAS MINIMUM) 4-6

NOTE

Landing distance will increase approximately 30 %. 4-6

Weight	$1.25V_S$
9,955	127
9,500	124
9,000	120
8,500	117
8,000	115
7,500	115
7,000	115

EMERGENCY EXIT DOOR OPERATION 4-6

1 Manual Pressure Control Valve ..... FULL DECREASE 4-6

When cabin depressurized: 4-6

2 Handle Access Cover ..... PUSH IN 4-6

3 Emergency Exit Door Handle ..... PULL, THEN LIFT DOOR UP AND INWARD 4-6

INADVERTENT ICING ENCOUNTER 4-6

NOTE

Conditions exist for icing when the outside air temperature (OAT) on the ground is +10°C or below or the indicated OAT (RAT) in flight is +10°C or below and visible moisture in any form is present. 4-6

AFM page

WARNING

IN THE EVENT OF AN INADVERTENT ICING ENCOUNTER, IMMEDIATE ACTION MUST BE TAKEN BY THE PILOT WHEN THE SITUATION IS DISCOVERED. 4-6
(1) MAINTAIN AIRPLANE CONTROL.
(2) CHECK ENGINE INLETS AND WING LEADING EDGES AND TAKE APPROPRIATE ACTION AS DESCRIBED IN THIS PROCEDURE.
(3) EXIT ICING CONDITIONS, IF REQUIRED.

IN ORDER TO MINIMIZE ICE ACCUMULATIONS ON UNPROTECTED LOWER SURFACES, MAINTAIN A MINIMUM SPEED OF 180 KIAS DURING OPERATIONS IN SUSTAINED CRUISE IN ICING CONDITIONS. THIS WILL PROVIDE AN ANGLE OF ATTACK THAT REDUCES EXPOSURE (FRONTAL AREA) OF THE LOWER SURFACES TO ICE ACCUMULATION. IF UNABLE TO MAINTAIN 180KIAS AT MAXIMUM CONTINUOUS POWER, A CHANGE IN ALTITUDE AND/OR COURSE MAY BE NECESSARY TO MAINTAIN MINIMUM AIRSPEED AND/OR TO EXIT THE ICING CONDITIONS. 4-7

IF ICE HAS BEEN ALLOWED TO BUILD UP ON THE ENGINE AIR INLET, IT MUST BE REMOVED AS SOON AS POSSIBLE. HOWEVER, BEFORE ACTIVATING THE ENGINE AIR INTAKE ANTI-ICE, THE PILOT SHOULD BE AWARE THAT AS THE ICE IS REMOVED, IT COULD DISRUPT THE AIRFLOW TO THE ENGINE AND RESULT IN FLAMEOUT OF THAT ENGINE. THE PILOT SHOULD BE PREPARED FOR THE POSSIBILITY OF SINGLE ENGINE OPERATION. 4-7

1 Anti-ice (except engine) ..... ON 4-7
2 Wing De-ice ..... ON 4-7
3 Ignition Switches ..... CONT OR ON 4-7
If Auto ignition is installed "CONT", if continuous ignition is installed "ON". 4-7
4 LH Engine Intake Anti-ice ..... ON 4-7
When proper operation of the LH engine is assured: 4-7
5 RH Engine Intake Anti-ice ..... ON 4-7
When proper operation of both engines is assured: 4-7
6 Ignition Switches ..... CONT OR ON, OBSERVE LIMITS 4-7
If auto ignition is installed "CONT", if continuous ignition is installed "ON". 4-7

		AFM page
	SEVERE ICING ENCOUNTER	4-7
	Severe icing may result with visible rain at temperatures below 0°C, or with droplets that splash or splatter on impact at temperatures below 0°C.	4-7
	Take steps to exit severe icing immediately.	
	Procedures for exiting severe icing environment are applicable to all flight phases from takeoff to landing. While severe icing may form at temperatures as cold as minus 18°C, increase vigilance is warranted at temperatures around freezing with visible moisture present. If the visual cues specified in the Operating Limitations Section of the AFM for identifying severe icing conditions are observed, accomplish the following.	4-7
1	Priority Handling ..... REQUEST	4-8
	Change route and/or altitude to immediately exit the severe icing and to avoid extended exposure to flight conditions more severe than those for which the airplane is certified.	4-8
2	Abrupt Maneuvering ..... AVOID	4-8
3	Control Wheel ..... HOLD	4-8
	If the autopilot is engaged, firmly hold the control wheel prior to disengaging the autopilot. If the autopilot is not engaged, it should remain disengaged.	4-8
4	Autopilot ..... DISENGAGE	4-8
5	Airspeed ..... INCREASE (180 KIAS MINIMUM IN CRUISE)	4-8
	If an unusual roll response, an uncommanded roll, or an unusual trim is observed, lower the nose (reduce the angle of attack) and allow the airspeed to increase before any reduction of engine power.	4-8
6	Power ..... MAINTAIN OR INCREASE	4-8
7	Flaps ..... MAINTAIN	4-8
	Do not extend flaps during extended operation in icing conditions.	4-8
	Operation with flaps extended can result in a reduced wing angle of attack, with the possibility of ice forming on the upper surface further aft on the wing than normal, possibly aft of the protected area.	
	If the flaps are already extended, do not retract them until the airframe is clear of ice.	
8	Report conditions to Air Traffic Control	4-8